

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 06-01-2008		2. REPORT TYPE Journal Article		3. DATES COVERED (From - To)	
4. TITLE AND SUBTITLE You're the Flight Surgeon: Pulmonary Decompression Sickness				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Lollis, Blake D., Lt Col, USAF, MC, FS				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. School of Aerospace Medicine Aerospace Medicine Department Graduate Medical Education 2601 Louis Bauer Brooks City-Base, TX 78235-5130				8. PERFORMING ORGANIZATION REPORT NUMBER AFRL-SA-BR-JA-2008-0018	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT You're the flight surgeon on call for about 1100 USAF pilots, boom operators, survival instructors, and other special operational duty personnel as well as their family members at a KC-135 base in the northern tier of the U.S. You receive a call about a flyer who had an altitude chamber ride earlier in the day and was now being transported by ambulance to the hospital with chest pain and difficulty breathing. What do you do? Through a series of questions and answers, this article guides you through the diagnosis, treatment, and follow-up of this patient. Diagnosis: Decompression sickness (DCS) with pulmonary symptoms (Type II DCS, older nomenclature). Treatment: Hyperbaric oxygen therapy under USAF TT6 or U.S. Navy TT6, which are both widely accepted as the ideal treatments for Type II DCS. The patient experienced a slight burning in his chest with slight cough upon return to ambient pressurization, so he was immediately taken down to 60 FSW and the U.S. Navy TT6 was repeated. Follow-up: The patient is put in a no-flying status for a week but will require no waiver because he has recovered uneventfully.					
15. SUBJECT TERMS Decompression sickness, hyperbaric oxygen therapy, Type II DCS, pulmonary symptoms					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 2	19a. NAME OF RESPONSIBLE PERSON Col Blake D. Lollis, USAF, MC
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (include area code)

YOU'RE THE FLIGHT SURGEON

This article was prepared by Lt. Col. Blake D. Lollis, USAF, MC, FS.

You are the flight surgeon on call for about 1100 USAF pilots, boom operators, survival instructors, and other special operational duty personnel as well as their family members at a KC-135 base in the northern tier of the United States. It is Friday night and all is quiet. Just before bedtime the phone rings and it is the base clinic. You listen calmly as the health technician on call informs you of something interesting. "Doc, I am sorry to bother you but I wanted to let you know I sent a flyer, who just this afternoon had an altitude chamber ride, downtown by ambulance to the hospital with chest pain and difficulty breathing. I wanted you to know as you are the flight surgeon on call."

1. You try to get your heart to stop racing and decide the most appropriate next step is which of the following?
 - A. Record the flyer's name and phone number in your "call-book" and check on him the next morning. After all, he is at a hospital which has a particularly good emergency department (ED) and hyperbaric medicine unit.
 - B. Call the ED and let them know you are the flight surgeon on call and would like to speak to the evaluating emergency room physician to inform him of his altitude chamber ride this very day. The patient can follow up with you on Monday in the clinic.
 - C. Dig out your Checklist, get dressed in your flight suit, grab your "on-call bag," and drive as quickly and as safely as possible downtown to evaluate the flyer. Even though you are not licensed in the state and have no admitting privileges, you may be of some help to the flyer.

ANSWER/DISCUSSION

1. C. It would be an extremely good idea to evaluate this patient yourself and communicate your suspicions to the evaluating emergency room physician. Additionally, the Flight Surgeon's Checklist is quite clear that any case of suspected decompression sickness in the USAF be discussed with the hyperbaric medicine specialists at Brooks City-Base to determine the disposition of the patient (7).

You arrive at the emergency room at the downtown hospital and identify yourself to the admitting desk. You ask permission to see the flyer and they are only too happy to allow you to do so. He has been here for about 40 min and was just seen by the emergency room physician minutes ago. He is a 30-yr-old Combat Rescue Officer (CRO). His wife is there with him. He reports the following to you, "Doc, I had to do my periodic physiologic training today and it went fine. I guess I got out of there at around 16:30. I drove home, ate supper, and began watching television when about an hour later I had a terrible burning pain in my chest, could not catch my breath, and had my wife call the ambulance. I have never felt like this before. I feel like I am suffocating!" You notice he has a resting tachycardia and that he is coughing, looks pale, and is rubbing his sternum with his left hand. His right arm has an intravenous line and you learn that he has just had his blood drawn for laboratory tests. He is on 4 L of oxygen by nasal cannula.

You perform a quick but thorough physical examination and the ER physician sees you and comes over to meet you. She introduces herself and informs you that she suspects an acute myocardial infarction and that she has given aspirin (325 mg), and has drawn cardiac enzymes which are pending. She shows you the flyer's EKG which reveals sinus tachycardia but is otherwise normal with no evidence of ST-segment elevation.

2. You decide the best course of action at this time is to do which of the following?
 - A. Tell the physician in as respectful manner as you can that you suspect the patient's condition is likely related to his hypobaric exposure.
 - B. Agree with the emergency room physician and suggest morphine as well as sublingual nitroglycerine.
 - C. "Fire" the ED physician and assume total control of the patient all the while barking about how smart you are for knowing what is best for your flyers and that you don't need any help from nonflight surgeons!

ANSWER/DISCUSSION

2. A. While it could be an acute myocardial infarction, this would be unlikely in this exceedingly fit, young man. The EKG also reveals no evidence of any cardiac pathology other than sinus tachycardia—probably the result of pain. Pain is indeed a part of decompression sickness, as well as air gas embolism. Answer "C" would be extremely unwise. You have no admitting privileges and are not licensed in this state. You need to have excellent rapport with the local physicians that provide care for your flyers and their family members when their required care outstrips what you and your medical treatment facility can provide. This patient's condition is likely a form of decompression sickness and is due to this patient's recent hypobaric altitude chamber training, but can also occur in a diver who ascends too quickly from depth (4).

As you discuss the case with the emergency room physician you suggest that the hyperbaric medicine specialist be called. She agrees and thanks you for coming in and for your advice. The hyperbaricist is called and is on the way; you return to your flyer's bedside. He is not looking any better. His legs are drawn up and he is lying on his side with a look of intense pain on his face. You breathe a sigh of relief a few minutes later when the attending hyperbaricist comes to the bedside. You present the case.

3. What is your most likely diagnosis?
 - A. DCS with bone/joint involvement (Type I DCS, older nomenclature).
 - B. DCS with Pulmonary Symptoms (Type II DCS, older nomenclature).
 - C. Air Gas Embolism.

ANSWER/DISCUSSION

3. B. This is likely pulmonary decompression sickness or a case of the "chokes" which is a severe form of decompression sickness (8). This is labeled as DCS with Pulmonary Symptoms. "Chokes" is thought to occur in as many as 10% of aviation decompression sickness cases (6). Type I DCS is usually a milder form of the disease (1). Examples of this are "the bends," whereby a patient has pain in a joint such as the knee or hip, and skin involvement (4). While this could possibly be a case of Air Gas Embolism (AGE), the history and presentation are not consistent with this flyer's presentation and condition (1). AGE usually, if not always, occurs upon rapid, uncontrolled ascent from diving and has occurred in as little as 4 ft (1.2 m) of water (3,4).

The attending hyperbaric medicine specialist asks you what you would like to do. You indicate that you believe the patient needs urgent hyperbaric oxygen (HBO) therapy. He agrees and asks you to call the hyperbaricists at Brooks City-Base to discuss the case as he readies the HBO facility for the treatment. You call and communicate with the hyperbaric medicine resident on call. He has you relate the history and physical examination and then asks you for your plan.

4. You tell him that this patient needs HBO therapy under which of the following?
 - A. USAF Treatment Table (TT) 5 (or U.S. Navy TT5).
 - B. USAF TT 6 (or U.S. Navy TT6).
 - C. USAF TT 6A (or U.S. Navy TT6A).

ANSWER/DISCUSSION

4. B. USAF TT 6 and U.S. Navy TT 6 are widely accepted as the ideal treatments for Type II decompression sickness (7). In either TT 6, the patient is placed in a hyperbaric oxygen chamber and is taken rapidly to 60 ft sea water (FSW) or 2.8 atmospheres absolute (ATA) pressure. This is thought to shrink the size of the nitrogen bubbles causing the patient's problem (2). Initially placed on 100% oxygen, the patient is given "air breaks" to avoid oxygen toxicity. The pressure is decreased after several hours to 30 ft FSW (2.0 ATA) and then to the surface (1.0 ATA) as long as the patient responds favorably. The basic difference between the two treatment tables is at the 30 FSW portions of the profiles and concerns the length and number of 100% oxygen and room

DOI: 10.3357/ASEM.86089.2008

YOU'RE THE FLIGHT SURGEON—LOLLIS

air breaks (9,10). Both TT 6s can be extended should there be a need based on symptom persistence (9,10). Tolerance of the U.S. Navy TT6 is excellent but claustrophobia is one condition that might limit its use, especially in monoplace chambers (11). Neither TT5 would be appropriate for a severe episode of decompression sickness, especially DCS with pulmonary symptoms, but would be appropriate for pain only "bends." A U.S. Navy TT 6A would be used for an air gas embolism affecting the cranial circulation (2,3).

Your flyer has been dressed appropriately in the proper fire-resistant scrubs and is placed in a monoplace chamber. You are anxiously observing him as the hyperbaric medicine specialist readies the chamber. Your flyer has turned an ashen color and is beginning to make peculiar "gulping" movements between his coughs. He has curled up in a fetal position. The door closes and the pressure soon begins to rise within the chamber. Within 5 mi of descending to 60 FSW the patient begins to relax. No longer ashen in appearance, the patient begins to rest comfortably. The patient is asked periodically how he is doing and answers that the pain has all but disappeared.

He is observed for the entire U.S. Navy TT6 and the patient is returned to ambient pressurization. At the "surface" he begins to complain of a slight burning in his chest with slight cough, but states that he feels much, much better.

5. The hyperbaricist asks you for further recommendations. The best recommendation is which of the following?
- A. It is probably okay at this time to discharge the patient back to his home. He has been given adequate treatment and is much improved over what his condition was at presentation.
 - B. Admit to a monitored bed and place the patient on oxygen at 2 L by nasal cannula. This will remove any residual nitrogen bubbles that might still exist.
 - C. The patient should immediately be taken down to 60 FSW and repeat the U.S. Navy TT6.

ANSWER/DISCUSSION

5. C. This patient may still have some residual bubbles in his pulmonary circulation and tissues, as evidenced by the returning symptoms. Oxygen by nasal cannula is unlikely to help this patient. Discharging him at this time would be unwise. He needs to have the U.S. Navy TT6 repeated. Only HBO therapy is likely to help. Discharging this patient before a U.S. Navy TT6 is repeated could very well be a fatal error (3).

The patient responds very well to this second U.S. Navy TT6 and is discharged to home the next morning. The hyperbaricist informs you that this patient needs to report to in your clinic for follow up on Monday morning and that you should be in communication periodically throughout the weekend to see how the patient is doing. He reminds you to call him immediately should the patient begin to decompensate. He also suggests that you call the USAF hyperbaric medicine resident to let them know that your patient is doing fine.

The patient continues to do well and you see him back in your office the first thing Monday morning. You call the USAF hyperbaric consultants that day with the patient in your office and they suggest that he not fly for a week. He will require no waiver as he has recovered uneventfully. This would also be true if he were a U.S. Navy, U.S. Army, or a civilian flyer. Of interest, this patient had the full 30-min 100% oxygen prebreathe before his altitude chamber ride. This "prebreathe" is thought to dramatically decrease the incidence of DCS in those pa-

tients exposed to altitude but DCS can occur even when procedures are followed perfectly (5,12).

LOLLIS BD. *You're the flight surgeon: pulmonary decompression sickness.* *Aviat Space Environ Med* 2008; 79:636–7.

ACKNOWLEDGMENTS

I would like to thank the USAFSAM Residency of Aerospace Medicine faculty for their direct and indirect assistance in making this article possible. I would also like to express my sincere thanks to Colonel (Dr.) Timothy Hursh, Chief, Hyperbaric Medicine Division at USAFSAM, for his advice and expertise in the technical aspects of this condition and its treatment, and for his careful review of this article. I would also like to thank the attending physicians and fellows at the Brooks City-Base Hyperbaric Medicine facility for their help on several "tense" evenings over the past 3 years. The views and opinions stated are solely those of the author and do not necessarily reflect those of USAFSAM or the U.S. Air Force.

REFERENCES

1. American Society of Aerospace Medicine Specialists. Clinical practice guideline for decompression sickness. 2007. Retrieved 15 July 2007 from http://www.asams.org/guidelines/Completed/NEW%20DCS_2.htm.
2. Bove A. Treating decompression illness. *Skin Diver*. 2001. Retrieved 15 July 2007 from www.skin-diver.com/departments/scubamed/Mar01.
3. Dehart R, Davis JR. *Fundamentals of aerospace medicine*, 3rd ed. Baltimore: Lippincott, Williams, and Wilkins; 2002: 67–98.
4. Germonpre P. The medical risks of underwater diving and their control—a review article. *Intl Sports Med J* 2006; 7:1–15.
5. Rice GM, Vacchiano CA, Moore JL, Anderson DW. Incidence of decompression sickness in hypoxia training with and without 30-min O₂ prebreathe. *Aviat Space Environ Med* 2003; 74: 56–61.
6. Rosenstock L, Cullen M, Brodtkin CA, Redlich CA. *Textbook of clinical occupational and environmental medicine*, 2nd ed. Philadelphia: Elsevier Saunders; 2005: 903–15.
7. Society of USAF Flight Surgeons. USAF flight surgeon's check list, 6th ed. Brooks City - Base, TX; 2002: XII: 40–43.
8. USAF School of Aerospace Medicine. USAF flight surgeon's guide-chapter 3: effects of decreased pressure: decompression sickness. Brooks City-Base, TX; 2002: 1–18.
9. USAF Oxygen Treatment Tables. Treatment Table (TT-5 and TT-6 and Carbon Monoxide) for treating decompression sickness. Tables found on Davis Hyperbaric Laboratory website. Retrieved 06 June 2007 from <http://tanktigers.net/Guide.htm>.
10. U.S. Navy Diving Manual. Revision 4, Volume 5, U.S. Navy Treatment Table 6: Oxygen treatment of type II decompression sickness (table 6). 1999; Chapter 21: 41. Retrieved 05 November 2007 from the U.S. Navy Diving Manual at www.coralspringsscuba.com/miscellaneous/usn_manual.htm.
11. Weaver LK. Monoplace hyperbaric chamber use of U.S. Navy table 6: a 20- year experience. *Undersea Hyperb Med* 2006; 33(2): 85–8.
12. Webb JT, Pilmanis AA. Altitude decompression sickness between 6858 and 9144 meters following a 1-hr prebreathe. *Aviat Space Environ Med* 2005; 76:34–8.